

Claims

1. A process for recovering at least one metal oxide from a titaniferous or aluminaferrous mixture comprising:
  - (A) smelting the mixture in the presence of a reducing agent to produce a molten slag;
  - (B) adding to the molten slag an alkali;
  - (C) isolating molten iron from the molten slag to produce a residual slag; and
  - (D) recovering the metal oxide from the residual slag.
2. A process as claimed in claim 1 wherein the titaniferous mixture is ilmenite, rutile or perovskite.
3. A process as claimed in claim 1 wherein the aluminaferrous mixture is an aluminium mineral or ore or red mud.
4. A process as claimed in claim 3 wherein the aluminaferrous mixture is bauxite or red mud.
5. A process as claimed in any preceding claim wherein the metal oxide is one or more of alumina,  $TiO_2$ ,  $Fe_2O_3$  and  $SiO_2$ .
6. A process as claimed in any preceding claim further comprising: recovering one or more metal hydroxides.
7. A process as claimed in any preceding claim wherein the at least one metal oxide is at least two metal oxides being  $TiO_2$  and  $Al_2O_3$ .
8. A process as claimed in any preceding claim wherein in step (A) substantially the whole of the iron present in the titaniferous or aluminaferrous mixture is reduced to molten metallic iron in the molten slag.

9. A process as claimed in any preceding claim wherein the metallic iron is steel.
10. A process as claimed in claim 9 wherein the reducing agent comprises or is molten cast iron and step (A) is carried out in a molten cast iron bath.
11. A process as claimed in claim 9 or 10 wherein the metallic iron is 0.8 to 1.0% C steel.
12. A process as claimed in any preceding claim wherein the reducing agent comprises: a source of carbon.
13. A process as claimed in any preceding claim wherein step (A) comprises smelting the mixture in the presence of a reducing agent and lime.
14. A process as claimed in any preceding claim wherein the alkali is a carbonate.
15. A process as claimed in claim 14 wherein the carbonate is a carbonate of a group Ia or IIA metal or a mixture thereof.
16. A process as claimed in claim 14 or 15 wherein the carbonate is selected from the group consisting of sodium carbonate and potassium carbonate.
17. A process as claimed in any preceding claim wherein the titaniferrous mixture is ilmenite and step (A) comprises smelting the mixture in the presence of up to 50% by stoichiometric proportion of an alkali/alumina mixture or sodium aluminate.
18. A process as claimed in any preceding claim wherein in step (C), the molten iron and residual slag are tapped separately.

19. A process as claimed in claim 18 wherein during tapping of residual slag, alkali is added by dosing.

20. A process as claimed in any preceding claim wherein step (D) comprises:

- (D1) adding to the residual slag an aqueous solution;
- (D2) separating a metallate solution from a metallate residue; and
- (D3) isolating the metal oxide from the metallate solution and/or from the metallate residue.

21. A process as claimed in claim 20 wherein step (D3) comprises:

- (D3a) precipitating metal hydroxide from the metallate solution.

22. A process as claimed in claim 21 wherein step (D3a) includes: bubbling CO<sub>2</sub> gas through (or passing oxalic acid into) the metallate solution.

23. A process as claimed in claim 22 wherein the CO<sub>2</sub> gas is generated during step (A).

24. A process as claimed in claim 20 wherein step (D3) comprises:

- (D3b) acid leaching the metallate residue to produce an acid leachate;
- (D3c) selectively precipitating from the acid leachate a hydrated salt of the metal oxide; and
- (D3d) converting the hydrated salt into the metal oxide.

25. A process as claimed in claim 24 wherein step (D3b) comprises:

- (D3b1) acidifying the metallate residue to produce a slurry;
- (D3b2) hydrolysing the slurry; and
- (D3b3) separating the metallate solution from an insoluble residue.

26. A method for recovering titanium dioxide from a titanium oxide-containing composition comprising:

- (a) roasting the composition in the presence of an alkali metal carbonate and an alumina-containing material to produce a roasted mass; and

(b) recovering titanium oxide from the roasted mass.

27. A method as claimed in claim 26 wherein the titanium oxide-containing composition is ilmenite, rutile or perovskite.

28. A method as claimed in claim 26 or 27 wherein the alkali metal carbonate is sodium and/or potassium carbonate.

29. A method as claimed in any of claims 26 to 28 wherein the alumina-containing material is alumina or  $\text{NaAlO}_2$ .

30. A method as claimed in any of claims 26 to 29 wherein step (b) comprises:

(b1) adding to the roasted mass an aqueous medium to produce an aqueous solution and an insoluble residue.

31. A method as claimed in claim 30 further comprising:

(b2) acid leaching the insoluble residue to produce an acid leachate; and  
(b3) recovering titanium oxide from the acid leachate.

32. A method as claimed in either of claims 30 or 31 further comprising:

(c) recovering alumina-containing material from the aqueous solution.

33. A method as claimed in any of claims 26 to 32 further comprising

(d) recovering carbon dioxide generated in step (a);  
(e) converting the carbon dioxide into an alkali metal carbonate.

34. A process for the extraction of metal oxides, which comprises the steps of:

(i) Reduction of a mineral ore (illmenite/bauxite/clay) and alumina-containing residues in the molten cast iron bath followed by treatment with an alkali and/or alkali mixture;

- (ii) Extracting the desired metal salt in the slag produced in step (i) using an aqueous and/or a dilute ammoniacal solution in aqueous media to separate water-soluble alkali aluminate from undigested metal oxide filter residue;
- (iii) Precipitation of aluminium hydroxide from alkali aluminate solution by bubbling CO<sub>2</sub> gas or oxalic acid medium for maintaining a constant pH,
- (iv) Calcining aluminium hydroxide formed in step (iii).
- (v) Acidifying the metal oxide filter residue salt to produce a hydrated salt; and converting the hydrated salt into an appropriate oxide.